Falling from the Sky

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Topic

Forces acting on falling objects

Time

3 hours

Safety

Please click on the safety icon to view the safety precautions. Be careful while cutting the fabrics. Be very careful when standing on a table or chair to drop the parachutes. Make sure that the furniture is sturdy enough to hold your weight and will not tip.

Materials

60 cm 2 60 cm each of various canopy materials:
- tissue paper
- plastic garbage bags
- nylon
- polyester
- silk
- other fabrics of different weights

tape
stapler
scissors
pen and pencil
ruler
stopwatch
paper clips
5-g mass (modeling clay, or small object)
sturdy chair or table to stand on

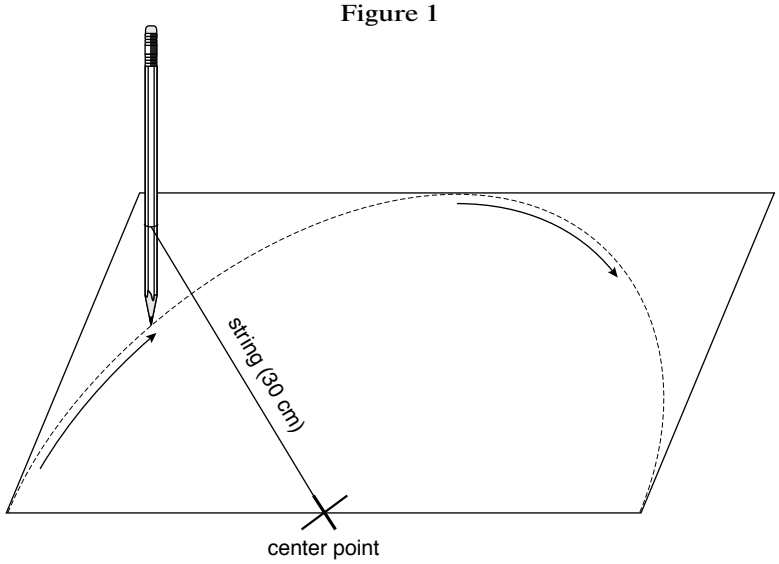
Procedure

Two experimenters are needed for the second part of this procedure.

Part A: Making the Parachutes

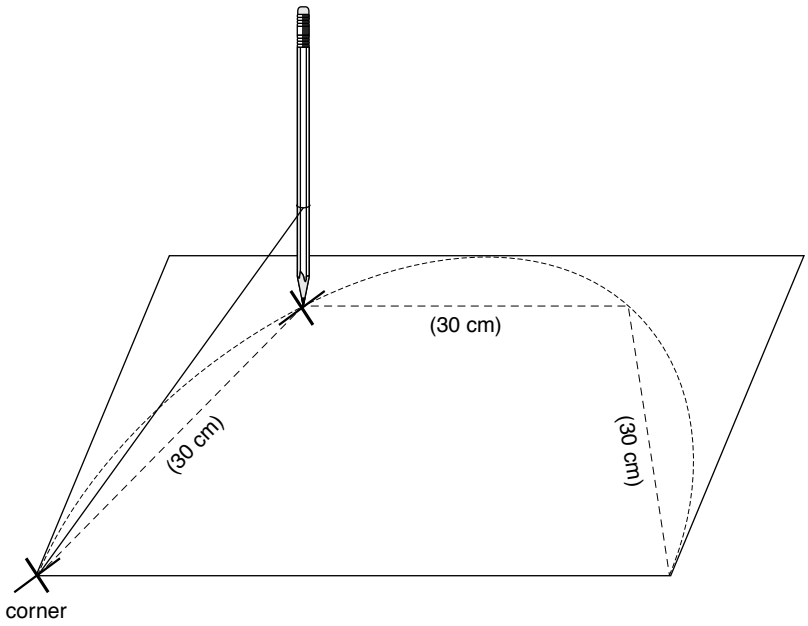
1. Fold canopy material in half.
2. Measure the length of the folded end, and mark the center point on it.
3. Attach a string to a pen or pencil, leaving a 30-cm length of string.
4. Use the pencil and string as a compass. Holding the free end of the string on the center point with a fingertip, mark a half circle with a radius of 30 cm on the material (figure 1).

Figure 1



5. Holding the end of the string on one corner of the semicircle, find the point where the pencil touches the circle, and mark this point. Do the same for the other corner. Using the ruler, draw lines to connect the marks, as shown in figure 2.

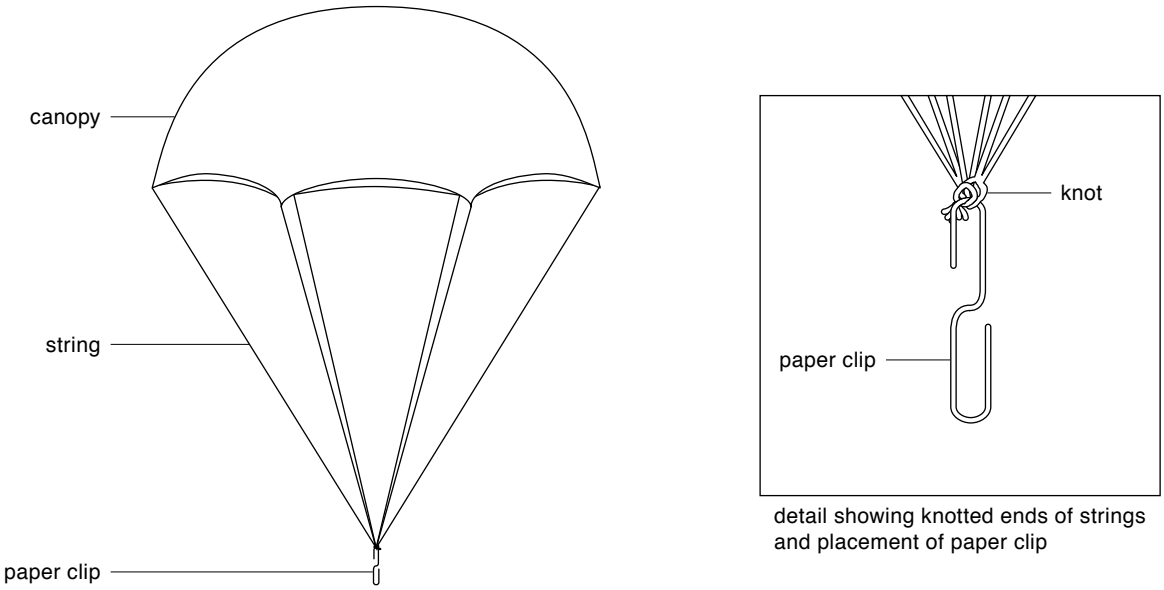
Figure 2



6. Cut the doubled thickness of material along the three lines shown in figure 2. Unfold the hexagonal shape that results.
7. Cut six strings to a length of 24 cm.
8. Tape and staple the end of each string to a corner of the hexagon.
9. Pull the corners of the canopy together, and stretch the strings together, making sure that they are all the same length.
10. Tie the ends of the strings together in a single knot so that the strings are all the same length from canopy to knot.
11. Unbend a paper clip into an S-shape, and attach it to the knot, as shown in figure 3.

12. Make at least three other parachutes from different materials, repeating steps 1 through 11.

Figure 3



detail showing knotted ends of strings and placement of paper clip

PART B: TESTING THE PARACHUTES

You will need a partner for this part of the experiment.

1. Climb onto the sturdy chair or table from which you will launch your chutes. Be very sure that the furniture is strong enough to hold your weight and will not tip or slide. Pick the parachute up from the center, and practice dropping it from the same height, in the same way, repeatedly. A good way to make sure that you are dropping from the same height each time is to raise your hand with the parachute in it all the way over your head, or else line up your hand against a mark on a wall. Find a good place to drop the parachute so that it will drop straight to the floor and not hit the wall or the edge of the chair or table.
2. When you have developed a good dropping technique, drop each parachute from the same height as many times as necessary to time five good (opened) descents. Have your partner use the stopwatch to time each descent, and record the time of each drop on data table 1. If a parachute fails to open, do not record the time of this drop.

DATA TABLE 1

Testing canopy materials

Canopy material	Drop time (sec)					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average

3. Roll a piece of modeling clay into a ball about 1.5 cm in diameter to make a mass of about 5 g, or tie together some other small objects, for example, metal washers, to make a comparable mass. Attach the weight to the paper clip on one of the parachutes.
4. Repeat steps 1 and 2, and record the results on data table 2.

DATA TABLE 2

Testing the effect of mass

Canopy material	Drop time (sec)					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average

5. Average the results of the five trials for each parachute, and record on the data tables the average drop time. (To take an average of five trials, add the five trial times together and divide by five.)
6. Which parachute made the slowest descent with just the paper clip?
7. Which parachute made the fastest descent with the paper clip alone?
8. Rank the parachutes in order of speed of descent in the first experiment with just the paper clip, from slowest to fastest. Explain what you think affected the speed of descent in these tests.
9. In the experiment using the extra mass, did the order you noted in step 8 stay the same? How did adding the added mass affect the parachutes' speed of descent?
10. Did the extra mass seem to change the path of the parachutes as they descended?
11. Using the information from both sets of tests, how should parachutes be designed?
12. You tested the effects on parachute descents of canopy material and mass carried. What might be some other factors affecting speed of descent that would be good to test for in different parachutes?

What's Going On

Generally, the parachute made of the lightest material makes the slowest descent; tissue paper and garbage bags descend slowly. Generally, the parachute made of the heaviest material makes the fastest descent; heavy polyester or denim descend quickly. The mass of the canopy material affects the speed of its descent. Lighter materials tend to spread out more, thus making a larger pocket to catch the air. The ranking will generally go from the lightest to the heaviest material, corresponding to the slowest-to-fastest descent.

Generally, the order from step 8 remains the same. Increasing mass speeds up the descents of all the parachutes. Yes, the parachutes fell straighter when carrying more mass, causing them to take a shorter path to the ground. Parachutes should be made of light materials. These materials should be strong enough to carry a wide range of weights, while guaranteeing the slowest possible descent. It might be good to test the reaction of different types of parachutes to air turbulence and moving weights. It's also important to test the strength of the canopy and lines and the maximum mass they can support before failure. The parachute's reliability of opening (the number of times the canopy opens correctly compared with the total number of drops) is another important factor.

Connections

Gravity pulls a falling object quickly to earth, while air resists the object's movement, slowing its fall. Parachutes are designed to take advantage of air resistance to greatly reduce the speed at which an object falls. In this experiment, you tested two variables—the material of the canopy and the mass it carries—to find out how they affect the rate of a parachute's descent.

Safety Precautions

READ AND COPY BEFORE STARTING ANY EXPERIMENT

Experimental science can be dangerous. Events can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. Basic safety procedures help prevent serious accidents. Be sure to follow additional safety precautions and adult supervision requirements for each experiment. If you are working in a lab or in the field, do not work alone.

This book assumes that you will read the safety precautions that follow, as well as those at the start of each experiment you perform, and that you will *remember* them. These precautions will not always be repeated in the instructions for the procedures. It is up to you to use good judgment and pay attention when performing potentially dangerous procedures. Just because the book does not always say "be careful with hot liquids" or "don't cut yourself with the knife" does not mean that you should be careless when simmering water or stripping an electrical wire. It *does* mean that when you see a special note to be careful, it is extremely important that you pay attention to it. If you ever have a question about whether a procedure or material is dangerous, stop to find out for sure that it is safe before continuing the experiment. To avoid accidents, always pay close attention to your work, take your time, and practice the general safety procedures listed below.

PREPARE

- Clear all surfaces before beginning work.
- Read through the whole experiment before you start.
- Identify hazardous procedures and anticipate dangers.

PROTECT YOURSELF

- Follow all directions step by step; do only one procedure at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure that there is adequate ventilation.
- Do not horseplay.
- Wear an apron and goggles.
- Do not wear contact lenses, open shoes, and loose clothing; do not wear your hair loose.
- Keep floor and work space neat, clean, and dry.
- Clean up spills immediately.
- Never eat, drink, or smoke in the laboratory or near the work space.
- Do not taste any substances tested unless expressly permitted to do so by a science teacher in charge.

USE EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives and other sharp or pointed instruments with caution; always cut away from yourself and others.
- Pull plugs, not cords, when inserting and removing electrical plugs.
- Don't use your mouth to pipette; use a suction bulb.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.

- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use only low-voltage and low-current materials.
- Be careful when using stepstools, chairs, and ladders.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read all labels carefully.
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING INSTRUCTIONS

- Use goggles, apron, and gloves when boiling liquids.
- Keep your face away from test tubes and beakers.
- Never leave heating apparatus unattended.
- Use safety tongs and heat-resistant mittens.
- Turn off hot plates, bunsen burners, and gas when you are done.
- Keep flammable substances away from heat.
- Have a fire extinguisher on hand.

WORKING WITH MICROORGANISMS

- Assume that all microorganisms are infectious; handle them with care.
- Sterilize all equipment being used to handle microorganisms.

GOING ON FIELD TRIPS

- Do not go on a field trip by yourself.
- Tell a responsible adult where you are going, and maintain that route.
- Know the area and its potential hazards, such as poisonous plants, deep water, and rapids.
- Dress for terrain and weather conditions (prepare for exposure to sun as well as to cold).
- Bring along a first-aid kit.
- Do not drink water or eat plants found in the wild.
- Use the buddy system; do not experiment outdoors alone.

FINISHING UP

- Thoroughly clean your work area and glassware.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Don't dispose of materials in the sink unless instructed to do so.
- Wash your hands thoroughly.
- Clean up all residue, and containerize it for proper disposal.
- Dispose of all chemicals according to local, state, and federal laws.

BE SAFETY-CONSCIOUS AT ALL TIMES